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IERI Procedia 5 (2013) 161 – 165

Procedia IERI

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2013 International Conference on Agricultural and Natural Resources Engineering

Study on the Optimization Mechanism about Behavior Selection of Healthy Pig Industry Chain

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Abstract

Because of the effect of factors such as technology improvement, cost saving and so forth, there is benefit conflict between enterprise and pig breeder of healthy pig industry chain in integration mode. According to the representation of the benefit conflict, the equilibrium point of behavior selection based on cost saving is analysed through static game and dynamic game theory, the optimization mechanism of behavior selection is built, and finally, safeguard measures which can resolve the benefit conflict and foster the synchronous growth of interests is presented.

Keywords: healthy pig industry chain, behavior selection, optimization mechanism, game theory

1. Introduction

Healthy pig industry chain is a collection of individuals or organizations to produce pollution-free (including green, organic) pigs and pork products, it includes the supply of feed, veterinary drugs, equipment, pig breeding, slaughter and processing, transportation and sale of pork. The chain's development goal is to

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doi:10.1016/j.ieri.2013.11.086

achieve pig health, environmental health, human health, and the industry chain health, to enhance the quality, value and benefits in pig industry, to achieve sustainable development of the pig industry.

The supply chain which regards appropriate scale pig farms, the integrate companies and supermarkets as node enterprise is effective organizational form of high-quality pork production. Investment and management cost in the develop process of healthy pig industry chain is obviously higher than normal pig industry chain. Therefore, the development of the healthy pig industry in the initial stage needs integrate companies which have big investment capacity, waste processing ability, brand market influence and high level of standardization to lead other subjects.

In the healthy pig industry chain, pig breeding is the core point to achieve pig health, environmental health, human health, and the industry chain health. The integrate companies help the pig breeder to improve the survival rate of pigs and feed conversion rate, reduce the marginal cost of pig breeding , increase the interests of pig breeding. But in order to get higher purchase price, the pig breeder will conceal their own cost saving information from integrated companies. Thus a conflict of interest between pig breeder and the integrated company will happen.

The literature that this paper has a connection to is the literature of finite automata in repeated games. Perhaps the most-cited paper in that literature is the seminal contribution of Abreu and Rubinstein (1988). They consider a game in which players choose Moore machines (finite automata) to play an infinitely repeated game. As Ely and Valimaki note in their paper, finite memory strategies are examples of finite automata. One might then wonder whether our results are not special cases of those proved in Abreu and Rubinstein (1988). And they are not. For the simple reason that those authors restricted attention to pure strategy equilibria, whereas, of course, the whole interest of our analysis is on the special kind of mixed strategy equilibria that we have called strong mixed equilibria.

2. Repeated game model about behavior selection

Suppose the integrate company and pig breeder are rational. The pig breeder choose an action such as conceal their own cost saving information or confession. The integrate company does not know which move the pig breeder has chosen but chooses an action such as supervision or neglect. The behavior of concealing cost saving information will be found when the integrate company chooses to supervise and the pig breeder will not conceal cost saving information any more. When the integrate company finds out the behavior of concealing cost saving information, he will not only punish pig breeder but also deprive pig breeder's additional income which is arising from costs saving. Thus the behavior selection of integrate company and pig breeder belongs to multiple repeated game.

Here R and R_B denotes separately the normal net income of the integrate company and pig breeder when cost saving happens, C denotes supervision fees of the integrate company, ΔR_B denotes pig breeder's additional income which is arising from concealing of cost saving information, ΔR denotes integrate company's potential losses which is arising from concealing of cost saving information, F denotes the punishment for pig breeder when the behavior of concealing is found out., $\lambda\ (0<\lambda<1)$denotes the distribution coefficient of additional income ΔR_B which should be distributed between the integrate company and pig breeder. In this game, each player has two strategies available. The payoff to the two players is first given by Table 1.

Table 1 Payoff about two player's behavior selection

Integrate company	Pig breeder	
	Conceal	Disclosure
Supervision	$R+F-C$, R_B-F	$R-C-\lambda\Delta R_B$, $R_B+\lambda\Delta R_B$
Ignorance	$R-\Delta R$, $R_B+\Delta R_B$	$R-\lambda\Delta R_B$, $R_B+\lambda\Delta R_B$

Suppose two player play this simultaneous move game N times, and the payoff for the entire game is the sum of the payoffs from the N stages. R_0 and R_{B0} denotes separately the initial net income of the integrate company and pig breeder before cost saving happens. As cost saving happens at T stage, a mixed strategy for pig breeder is the probability distribution $(u,1-u)$, where u is the probability of concealing, $1-u$ is the probability of disclosure and $0 \le u \le 1$. At the same time, a mixed strategy for integrate company is the probability distribution $(v,1-v)$, where v is the probability of supervision, $1-v$ is the probability of ignorance and $0 \le v \le 1$. At N stages repeated game, the net income of pig breeder when he disclosure or conceal the cost saving information is given by($\delta \in (0,1)$ is the discount factor)

$$E_v(0)=\sum_{t=1}^{T-1}\delta^{t-1}R_{B0}+\sum_{t=T}^{N}\delta^{t-1}(R_B+\lambda\Delta R_B)$$

$$E_v(1)=(1-v)[\sum_{t=1}^{T-1}\delta^{t-1}R_{B0}+\sum_{t=T}^{N}\delta^{t-1}\left(R_B+\Delta R_B\right)]+v\left[\sum_{t=1}^{T-1}\delta^{t-1}R_{B0}+(R_B-F-\Delta R_B)\delta^{T-1}+\sum_{t=T+1}^{N}\delta^{t-1}R_B\right] \text{ let}$$

$$E_v(0)=E_v(1),\ v^*=\frac{\Delta R_B(1-\lambda)\left(1-\delta^{N-T+1}\right)}{\Delta R_B\left(1-\delta^{N-T+1}\right)+\left(F+\Delta R_B\right)(1-\delta)}$$

To pig breeder, concealing the cost saving information is the best response if and only if the probability of supervision $v \ge v^*$, conversely, offering the cost saving information is the best response if and only if the probability of supervision $v \le v^*$.

At N stages repeated game, the net income of integrate company when he supervise or ignore pig breeder is given by

$$E_u(0)=u\left[\sum_{t=1}^{T-1}\delta^{t-1}R_0+\sum_{t=T}^{N}\left(R-\Delta R\right)\delta^{t-1}\right]+(1-u)\left[\sum_{t=1}^{T-1}\delta^{t-1}R_0+\sum_{t=T}^{N}\delta^{t-1}\left(R-\lambda\Delta R_B\right)\right]$$

$$E_u(1)=u\left[\sum_{t=1}^{T-1}\delta^{t-1}R_0+\left(R-C+F\right)\delta^{T-1}+\sum_{t=T+1}^{N}\delta^{t-1}\left(R-C\right)\right]+(1-u)\left[\sum_{t=1}^{T-1}\delta^{t-1}R_0+\sum_{t=T}^{N}\delta^{t-1}\left(R-C-\lambda\Delta R_B\right)\right]$$

$$let\ E_u(0)=E_u(1),\ u^*=\frac{C\left(1-\delta^{N-T+1}\right)}{\Delta R\left(1-\delta^{N-T+1}\right)+F\left(1-\delta\right)}$$

To integrate company, supervision is the best response if and only if the probability of concealing $u \ge u^*$, conversely, ignorance is the best response if and only if the probability of supervision $u \le u^*$.

3. Optimization mechanism about behavior selection

To reduce the probability of concealing cost saving information and the cost of supervision, improve the net profit of integrate company, alleviate the conflict of interest, integrate company should take effective measures to increase the degree of openness about pig breeding, improve the quality of supervision personnel and the degree of information completeness, increase the income of technological innovation and invest in pig breeding. According to the representation of the benefit conflict, the equilibrium point of behavior selection based on cost saving, the optimization mechanism of behavior selection is built, as shown in Figure 1.

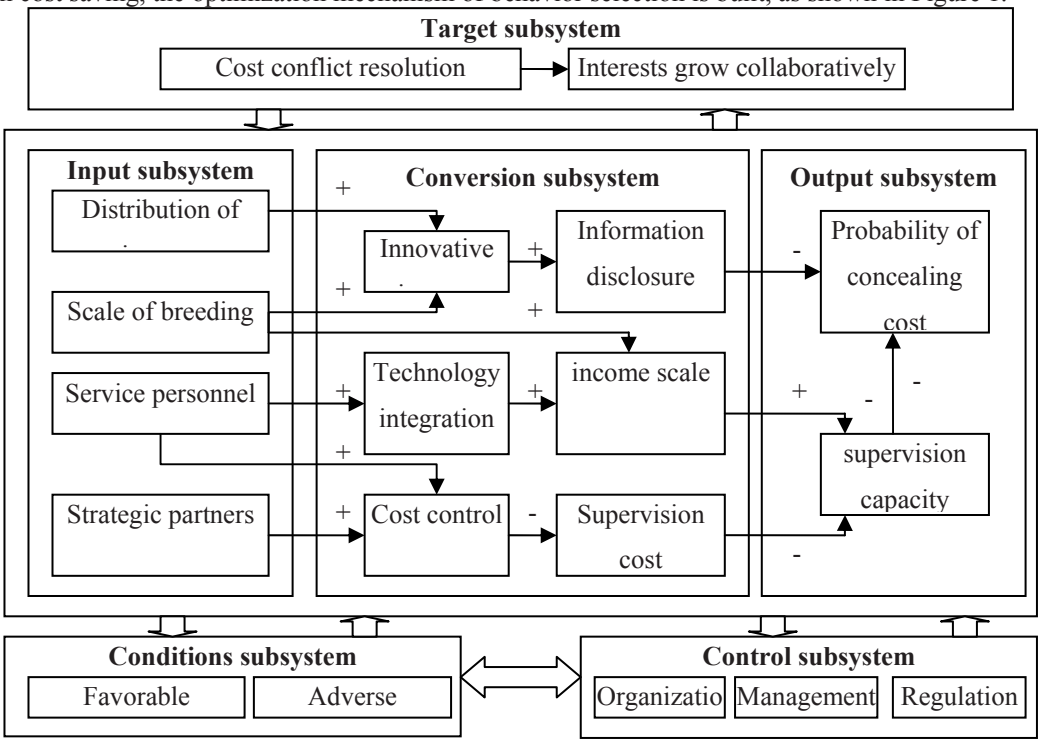

Figure 1 The Optimization Mechanism about Behavior Selection of healthy pig industry chain

The running target of mechanism is to resolve the conflict of interest caused by cost savings and make interests to grow collaboratively. By improving the motivity of information disclosure of pig breeder and reducing the supervision cost of the integrated company, the supervision capacity of the integrated company is enhanced and the probability of concealing the cost information is reduced.

4. Conclusion

As strategy executor, the integrated company and pig breeder should take powerful safeguard measures to reduce the interest conflict, make interests to grow collaboratively. The integrated company should improve the performance appraisal management of pig breeder, establish the perfect pork and pig products' pricing and costing system. the organizational mode of healthy pig industry chain should firstly choose integration dominated mode, then evolve to strategic alliance dominated mode.

Acknowledgements

The research reported in the article was funded by East China Institute of Technology Dr. Fund project (DHBK1004)

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